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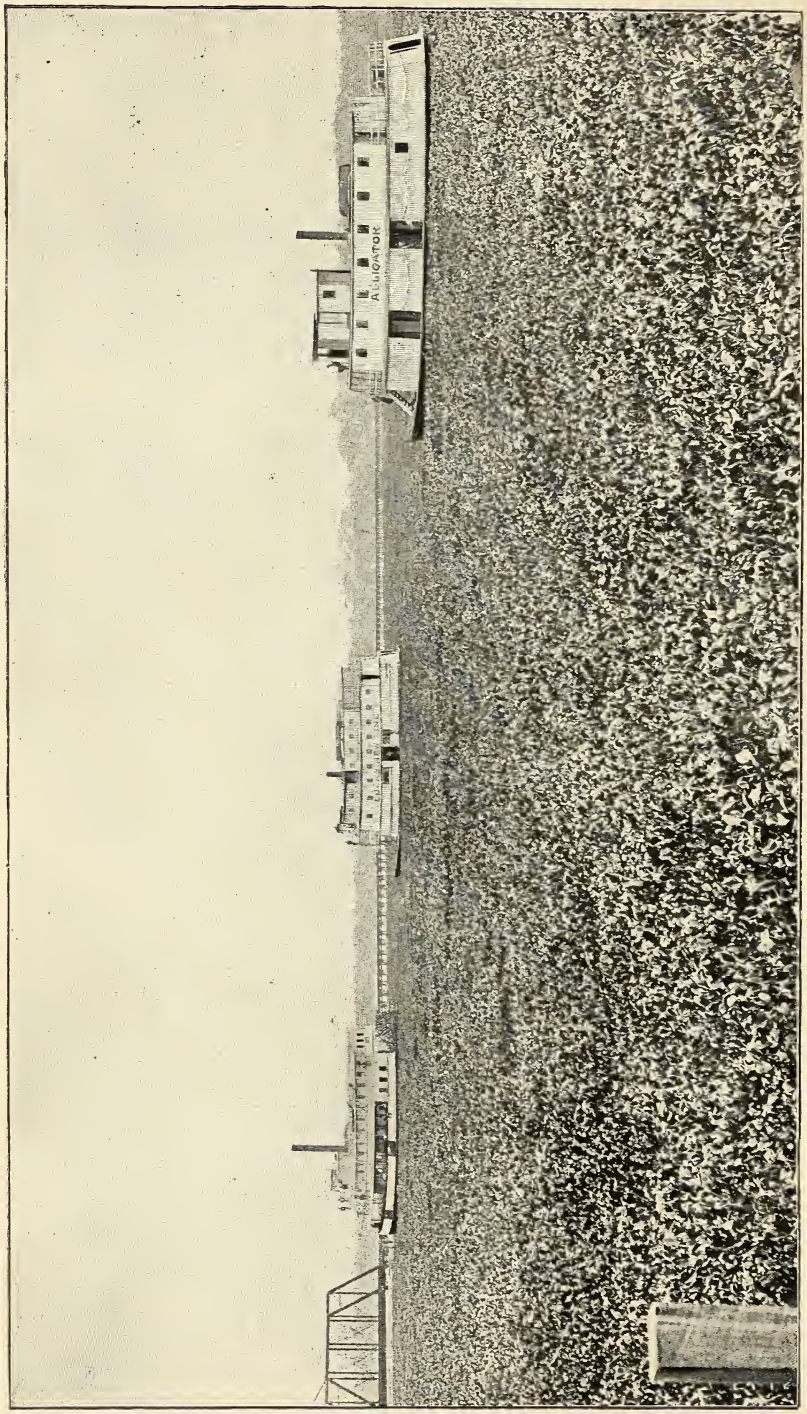

BLOCK OF WATER HYACINTH AT THE PALATKA BRIDGE, ST. JOHNS RIVER, FLORIDA.

BULLETIN No. 18.

U. S. DEPARTMENT OF AGRICULTURE.

DIVISION OF BOTANY.

THE WATER HYACINTH,

AND ITS RELATION TO NAVIGATION IN FLORIDA.

BY

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Division of Botany,
Washington, D. C., April 5, 1897.

Sir: For several years past an aquatic plant known as the water hyacinth has been developing to such an enormous extent in the St. Johns River, Florida, as to cause serious apprehension in that region regarding its possible obstruction to navigation. About two years ago the War Department was asked to investigate the matter, and did so. In the last session of the Fifty-fourth Congress bills were presented proposing an appropriation for fully investigating and for removing the obstruction, and one of these bills has again been presented to the Fifty-fifth Congress. In answer to urgent requests for exact information on the subject, the Department of Agriculture, on January 25, 1897, directed one of its agents, Mr. Herbert J. Webber, an assistant in the Division of Vegetable Physiology and Pathology, to visit the region and prepare a report covering the following points: (1) Historical notes regarding the plant, including its habitat, manner of growth, propagation, and anatomical and physiological characters; (2) an account of its introduction and spread in Florida; (3) the present distribution of the plant in the State and its effect on navigation and commerce; and (4) possibilities of exterminating it.

I have the honor to submit Mr. Webber's report herewith, for publication as Bulletin No. 18 of the Division of Botany.

Respectfully,

Frederick V. Coville,
Botanist.

Hon. James Wilson,
Secretary of Agriculture.

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THE WATER HYACINTH AND ITS RELATION TO NAVIGATION IN FLORIDA.

GENERAL NOTES.

The water hyacinth[1] is a native of tropical South America. It has clusters of light-blue or violet flowers and blooms freely, and this has led to its being widely cultivated in Europe and America. In tropical and subtropical America, according to Schönland,[2] it is a common and widely distributed weed. The plant is aquatic and commonly floats on the surface of the water, without attachment to the soil. If the water is shallow, however, the roots may grow into the soft mud and become firmly attached. In many places on the banks of the St. Johns River the plants may be found growing on the marshy, muddy banks, where the roots have a firm attachment to the soil. If the plants are to succeed, however, the soil must be thoroughly saturated with water and of a loose texture. Even under such conditions they are evidently not entirely suited, as they do not grow as large as when floating. If the soil becomes comparatively dry, the plants die.

The leaves of the water hyacinth form a rosette from 1 to 2 feet high. This remains above water as the plant floats. The basal portions of the leaf stalks of young plants are strongly swollen (fig. 1). As the plant becomes older these swellings gradually disappear and the petiole lengthens and becomes of nearly equal thickness throughout, or gradually tapers from the base to the leaf blade.[3] The swellings on the petioles of the young leaves act as air reservoirs. In this way they insure the stability of the young plant, keeping it from sinking and preventing it from being overturned by wind or waves. Old plants become so thoroughly entangled that they can be torn apart only with considerable difficulty and are in no danger of being overturned. Their long petioles are provided with large air chambers, which probably contain more air than the short, swollen leaf stems of the young plant. The roots form a dense, bushy mass, in many cases reaching a length of over 2 feet.

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[1] Technically known as *Piaropus crassipes* (Mart.) Britton; known also in scientific publications as *Eichhornia speciosa* Kunth, and *Eichhornia crassipes* (Mart.) Solms.—F. V. C.

[2] Schönland, S., Pontederiaceae, in Engler and Prantl, die Natürlichen Pflanzenfamilien, Theil II, Abt. 4, p. 73. 1888.

[3] Compare Goebel, Pflanzenbiologische Schilderungen, Theil II, S. 254. 1893.

The water hyacinth is mostly limited in its growth to sluggish fresh-water streams, bayous, lakes, ponds, etc. The character of the water appears to have much to do with its growth. In the St. Johns River and its tributaries, where the plant has spread so rapidly, the water is yellowish or brownish, probably owing to the presence of considerable humic acid and organic matter. In clear lakes, where the water is fairly pure, and in Silver Springs Run, where the water is clear and hard, the water hyacinth forms only small, stunted plants. In Blue Springs, in which sulphur is sufficiently abundant to be plainly per-

FIG. 1.—Water hyacinth.

ceptible to the taste and smell, the plant is said to be unable to survive. It can endure only a small percentage of salt and is killed when it floats down into the sea water. In the lower portions of the St. Johns River (below Mandarin) the water is evidently too brackish for the successful growth of the plant, as it here becomes less abundant, notwithstanding the fact that floating masses from the upper portion of the river are continually carried down by the current.

In Florida the plants are generally found lining the shores of the lakes and rivers in immense numbers. In Monroe, Dexter, George,

and other lakes, practically the entire shores are lined with a solid mass from 50 to several hundred feet wide. Small coves protected from the wind are usually entirely covered. The same conditions prevail all along the St. Johns River from Lake Harney to Green Cove Springs. The margins are lined on each side by a broad belt of plants, and all coves, bayous, marshes, and small tributary creeks are entirely covered (fig. 2). The main channel of the river remains clear unless masses of the plants become so packed together as to produce a block.

In most places, as described above, the hyacinth grows to some extent on the wet, muddy shores of the rivers and lakes, all stages of connection with the soil occurring as the water becomes deeper. In the course of growth and propagation the stolons become so entangled that the

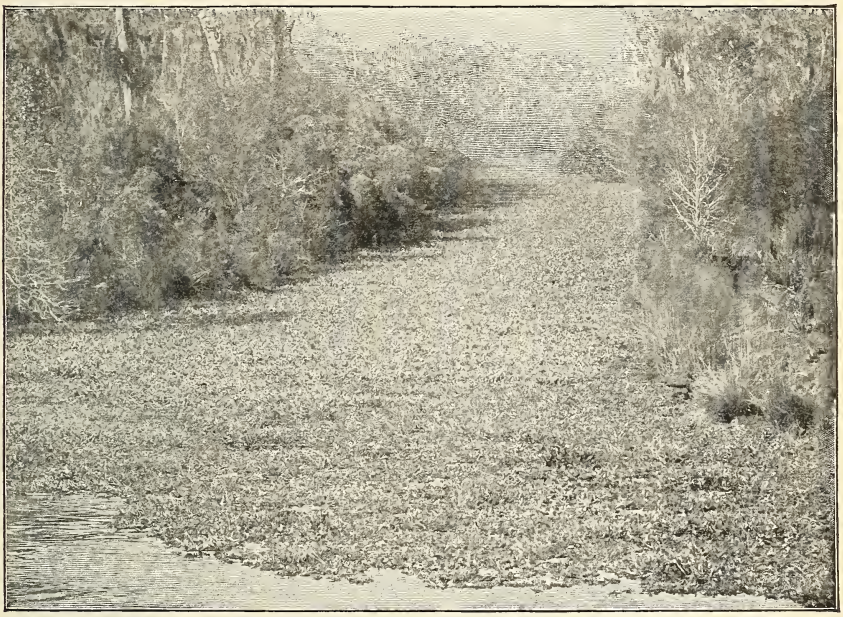

FIG. 2.—Creek covered with water hyacinth.

plants whose roots penetrate the soil serve to moor large floating masses to the shore. Occasionally the wind or current tears masses of the plants loose and these drift with the current or are blown here and there by the wind. The quantity of hyacinths present at any point on the shore varies greatly from week to week, as the wind largely determines their position. This is particularly true in large lakes. A steady west wind will in a few hours loosen and start great masses of the plant from the west shore of a stream toward the east; a strong south wind will start large masses downstream; while a strong north wind, possibly aided by the tide,[1] will start masses up-stream. It is this habit of shifting, principally, that causes the obstruction of navigation.

[1] The tide is noticeable as far up the river as Lake George.

In the sharp turns of the narrow portions of the river the plants are caught and form blocks which sometimes extend for several miles. At one time during the summer of 1896 a strong north wind drove the plants from Lake George up the river and formed a solid mass entirely covering the river for nearly 25 miles. At the same time, it is said, the south end of Lake George was covered with an unbroken mass of plants for nearly a mile from the shore.

The current carries large masses down the stream and out to sea (fig. 3). Tides and winds carry the plants up-stream to some extent, but the general tendency is downstream. The current in the St. Johns River is sluggish, being only about a mile and a half per hour, yet its effect in carrying the plants out can readily be seen by the blocks formed against the railroad bridges, which obstruct the passage of the plant. This is particularly the case at Palatka, where there are almost invariably large accumulations. The bridges across the St. Johns, with the exception of that at Jacksonville, are pile bridges, which offer consider-

FIG. 3.—Floating masses of water hyacinth.

able obstruction to the floating plants (Pl. I). In several instances the bridges are strengthened by stringers, which run from pile to pile just at or below the surface of the water, making the obstruction much more effectual. In such cases the span of the drawbridge (75 to 90 feet) is the only outlet for the plants. The bridges as at present constructed retard the passage of the plants out to the sea, and are thus unquestionably a great hindrance to the clearing of the channel. Wide-span bridges offer but little obstruction, and should be required in all permits granted for bridges over infested streams.

In streams with deep, swift currents it is not probable that the weed will ever seriously interfere with navigation. In the Ocklawaha River the current is much stronger than in the St. Johns, being, in the upper part of the river, near Silver Springs Run, about 3½ miles per hour, and in the lower part, near its mouth, about 2½ miles per hour. While this stream is very tortuous, the weed has not accumulated to any serious extent along the shores and no blocks have occurred. The swift current tears the plants loose from the shore as soon as they extend into the

river beyond the projecting roots of the trees, and hurries them down the stream and eventually into the St. Johns River. The boatmen and lumbermen who navigate the Ocklawaha do not think the weed will ever form any obstruction to navigation here, and this opinion would seem to be well founded.

METHODS OF PROPAGATION.

The water hyacinth is normally propagated by seeds and by stolons. The writer has been unable to ascertain positively whether the plant in Florida forms seeds, but the evidence obtained strongly indicates that it does.[1] The flowering is very profuse, and there seems to be no reason why seeds should not mature. The propagation by stolons is very rapid and effectual. The stolons branch out from the old stem, extend from 4 to 8 inches from the parent plant, and form on their ends a little rosette of leaves (fig. 1). Roots spring from the node where the rosette is formed, and the young plant soon becomes self-supporting. Old plants will usually be found to have formed several (three to five or more) stolons, which branch out in different directions. Several generations of plants produced in this way may frequently be found connected by the old stolons, which are usually about one-half an inch in diameter and are very strong. The writer has several times counted from twenty to thirty plants so attached. As the plants usually grow close together the newly developed offshoots bind the mass firmly together, so that it is difficult to separate the individual plants.

INTRODUCTION AND SPREAD OF THE WATER HYACINTH IN FLORIDA.

Nothing accurate has been learned as to when the water hyacinth was first cultivated in the State for ornament. It has been many years under cultivation in Northern hothouses and has probably been grown in Florida for a considerable time. As nearly as can be learned, however, it was first introduced into the St. Johns River about 1890, at Edgwater, about 4 miles above Palatka. At this place it had been grown for some time in a pond, and when it was desired to clear the place out the plants were thrown into the river. Here they grew luxuriantly, producing beautiful masses of flowers, which rendered the

[1] In a fountain basin in the yard of Dr. R. P. Daniels, of Jacksonville, Fla., the water hyacinth was grown for several years. When it was desired to kill it, all the material visible was carefully taken out, but the plants came up again. The water was then drained off and the earth thrown out of the fountain basin and allowed to dry for about three months, during which time it was exposed to the severe freezes of 1894–95, and then replaced, no living portions of the plant being observed in the operation. In a short time, however, numerous minute plants, which proved to be young water hyacinths, appeared on the bottom. In this case it is thought that the plants must have come from seeds. The writer has also learned of another similar case. In this connection it is interesting to recall that Fritz Müller has shown that the seeds of the water hyacinth will not germinate until they have been dried out (Kosmos, 1883, VII, Heft 4, pp. 297-300; review in Bot. Centralbl., Bd. 16, p. 299).

river attractive. At this time no one had any idea the plant would become a nuisance, and it was carried by settlers up and down and introduced at different points to beautify the river in front of settlements. It was also distributed by boats passing up and down, and it soon became abundant up as far as Lake Monroe and down as far as the increasing brackishness of the water allowed its growth. In 1894 the water hyacinth had become so abundant that it began to attract the attention of steamboatmen and fishermen, although at that time the amount was not sufficient to cause trouble. After the severe storms of October, 1894, which carried the plants out of the bayous and creeks, they were noticed to be very abundant.

In October, 1894, some plants were carried up the Ocklawaha River, the main tributary of the St. Johns, and placed in a pool at Howard's Landing, 14 miles down the river from Silver Springs. This became the seed bed for the entire lower and navigable portions of the Ocklawaha River. The plants multiplied rapidly and were crowded out into the river. The current carried them downstream and has spread them along the entire lower portion of the river.

PRESENT DISTRIBUTION IN FLORIDA.

So far as can be learned, the distribution of the water hyacinth in Florida is limited to the St. Johns River and its tributaries and a few inland lakes and ponds. It extends down the river in great abundance as far as Doctors Lake or Mandarin. Beyond this point it may be found in considerable quantity, usually floating down the river, but the water is evidently too salty for the healthy growth of the plant. It is abundant as far up as Lake Harney and has been introduced in places still farther up the river, occurring to some extent, the writer is informed, as far as Puzzle Lake. From Lake Harney to Green Cove Springs, a distance of over 200 miles, it is very abundant. In the Ocklawaha River it lines the shores from the mouth of Silver Springs Run to the St. Johns River, a distance of about 100 miles. It has spread only a few miles up the Ocklawaha above the entrance of Silver Springs Run. There is no navigation above this point, and as the current of the stream is swift it is difficult for the plant to extend in this direction. The writer is informed by those who know the river at this point that the water hyacinth has now extended about 5 miles above Silver Springs Run. Occasional plants may be observed in this stream, but the water is evidently not suited to them and they remain small and do not propagate rapidly. As far as the writer has been able to learn by personal observation and inquiry, the large lakes, comprising the head waters of the Ocklawaha (Lakes Harris, Dora, Eustis, Griffin, and others), remain free from the pest. Deep Creek and Crescent Lake, through which the regular line of boats run and on the shores of which are extensive and valuable lumber forests, are badly infested. Rice Creek, Black Creek, and almost all the numerous small tributaries of

the St. Johns, are covered by a solid mass of the plant (fig. 2). As far as can be learned, the Wekiva River, which contains large quantities of the water lettuce (*Pistia stratiotes* L.), has become infested with the water hyacinth only for a short distance up from its confluence with the St. Johns. Certain small lakes at Orlando, Tampa, and Ocala are known to be infested, and it is probable that there is a considerable number of lakes in the State where it has been introduced. The navigable rivers of the State other than the St. Johns, such as the Kissimmee, Withlacoochee, Suwanee, and Apalachicola, are as yet apparently free from the weed. However, it is liable to be introduced into these streams at any time for cattle food or because of its showy flowers, and precautionary measures should be taken to prevent its further spread. Stockmen are said to have carried the plant up the St. Johns River by the boat load to introduce and spread it as food for their cattle.[1]

DAMAGE CAUSED BY THE WATER HYACINTH.

EFFECT ON NAVIGATION.

That the water hyacinth is becoming a serious menace to navigation in the St. Johns River is unquestionably true. Small boats with screw propellers find it impossible to penetrate a very large mass of the plants, as they lack the necessary power, and the plants soon become entangled in the screw and prevent it from revolving. Parting the plant with boat hooks, etc., is very slow and tedious. Paddle-wheel steamers are able to penetrate the extensive masses of the plants much better, but are generally hindered and frequently entirely blocked. When a large steamer going at full speed strikes a bank of the hyacinths, it comes almost to a standstill. In side wheel steamers the plants collect between the wheel and bulkheads, packing in so solidly that it is often almost impossible to reverse the engine. This necessitates caution in approaching the landings. Steamers with low-pressure engines are troubled by the clogging of the injection pipes so that sufficient water can not be secured for the condensers. In the case of some boats the obstruction is occasionally removed by blowing steam through the injection pipe. This process, however, is rather dangerous, as the injection pipes and condensers are not constructed with a view to having heavy pressure applied from within. Floating logs frequently lie concealed in the masses of the plants and form a serious danger to navigation. Several boats have already been injured to some extent by striking such obstructions.

In large lakes, like Lake George, and in wide portions of rivers, there is some danger of steamers being caught between floating masses of the plants, carried out of the channel, and stranded. The *City of Jacksonville*, the largest and most powerful steamer plying on the St.

[1] The writer is of the opinion that the State should enact laws making the introduction of the water hyacinth into rivers and into lakes having outlets a misdemeanor.

Johns, at one time in the fall of 1896 had great difficulty in avoiding this. Small launches, rowboats, sailboats, etc., have in several instances been caught between masses of the floating plants and have found it impossible to get out without aid. In many places it has become dangerous to use small boats.

Similar difficulties have been encountered in northern South America, the native home of the plant, where it frequently becomes so abundant in sluggish streams as to be a serious obstacle to navigation. Goebel, a German botanist, says that "in many streams in Guiana the plant has become a plague to steamers, as it frequently almost entirely covers the surface and easily becomes entangled in the ship's screw."[1]

The rapid increase of the water hyacinth in the St. Johns River in the short time since it was introduced strongly indicates its still further increase if means are not found to keep it in control. Should it become much more abundant, navigation will be entirely stopped—at any rate in the upper portion of the river south of Palatka. This would mean a serious disaster to a large and important region of the State. About eight steamers ply regularly up and down the St. Johns and Ocklawaha rivers, carrying freight, mail, and passengers. The entire section reached by the St. Johns River steamers is, furthermore, greatly benefited by the low freight rates secured owing to water competition. The rates where competition exists are only about one-half or one third those to places of equal distance not having water transportation. Should the water hyacinth become much more abundant, many of the small tugs and launches now doing business on the St. Johns River will be unable to run.

EFFECT ON THE TIMBER INDUSTRY.

Bordering the St. Johns River and its tributaries are extensive and valuable forests of cypress, pine, and red cedar, which are largely sawed by mills located in Palatka and Jacksonville. The logs are cut and rafted down the St. Johns to the mills, much being saved by transporting them in this way. Over twenty tugs, it is said, are engaged in this rafting business. Great difficulty has been experienced by the lumbermen in getting their rafts out of the small tributaries, which become entirely covered by dense masses of the water hyacinth (fig. 2). From Palatka alone there is shipped annually about 55,000,000 feet of lumber, representing a value in the raw material of about $110,000. The difficulty in rafting caused by the water hyacinth is estimated by lumbermen to cause a loss of about one-fourth the value of the logs, so that the yearly loss to lumbermen at Palatka from this pest would thus be about $27,500. At present twice this amount, or $55,000, would probably be a fair estimate of the yearly damage to the lumber industry of the entire river.

[1] Pflanzenbiologische Schilderungen, 2, p. 255. 1893.

EFFECTS ON THE FISHING INDUSTRY.

Fishing for shad and other fresh-water fish has for years been an important industry on the St. Johns River. Since the water hyacinth has become abundant, however, much difficulty is experienced in operating the nets. Occasionally at certain places fishermen are unable for days at a time to use their nets, or do so at great risk, as the net may be caught between floating masses of the hyacinth and carried away. All along the river it is difficult to find clear places on the banks on which to land the nets, and it is usually necessary to spend some time in clearing the water hyacinth away in order to provide a suitable place. The detritus of dead plants which accumulates on the bottom of the river is also some hindrance to fishermen. Previous to the introduction of the water hyacinth the bottom of the river in most places was sandy and clear of obstruction. Now in many places, the writer is informed, the decaying plants have collected in masses several feet deep. On the fish, however, the effect of the rapid spread of the plant has apparently been beneficial, as they are more abundant now than ever before. Fishermen think this is due to the protection which the masses of vegetation afford to the young fish.

Should the hyacinth spread in the next four years as rapidly as it has in the past four, fishing with nets will probably have to be abandoned. The obstruction has already become serious in some places. One fisherman, having about 30 men employed constantly, informs the writer that he has been damaged to the extent of over $1,000 this year by the loss of time and nets caused by the water hyacinth. Probably 500 men along the St. Johns depend upon this industry for their sustenance.

EFFECT ON BRIDGES.

In floods the banking up of the masses of water hyacinth, and the resistance offered thereby to the passage of water, is liable to prove disastrous to bridges. The railroad bridge across Rice Creek was considerably injured during the flood of 1894, some 65 feet of the trestle being destroyed. The force of the water in this was doubtless greatly increased by the presence of the hyacinth. Some trouble is also experienced by the washing produced by undercurrents caused by the plants banking up against the bridges. At the Buffalo Bluff bridge men have been employed to push the plants through to prevent a block.

EFFECT ON HEALTH.

There is much complaint of the unwholesome conditions produced by the water hyacinth, particularly in the towns of Palatka and Sanford. While the plant itself is not directly injurious to health, the accumulation of large masses of decaying vegetable matter on the banks and in lagoons probably affects the general healthfulness of a region. When the wind blows steadily in one direction for some time,

it piles many of the plants upon the shore, where they are left to rot. Again, the blocking of small streams may interfere with drainage and the passage of sewage waters, and thus render conditions unhealthful.

POSSIBILITIES OF EXTERMINATING THE PLANT.

As explained above, the water hyacinth lines the shores of the St. Johns River from Puzzle Lake to Mandarin, being very abundant from Lake Harney to Green Cove Springs, a distance of considerably over 200 miles. Throughout this entire distance the shores of the river and the numerous large lake expansions are lined with a border of the plant from 25 to 200 feet wide. The coves, bayous, marshes, and creeks, with few exceptions, are covered by a continuous dense mat of the plants. No reliable data can be secured as to the actual extent of the coast line, but in the St. Johns alone, not including the Ocklawaha, it would probably exceed 1,000 miles. The Ocklawaha River, which is badly infested for over 100 miles of its length, would greatly increase the coast line, which must be considered if extirpation is proposed.

Extirpation, if successful, means the destruction of every plant and every seed or rootstock which may give rise to a new plant. It would be comparatively easy to destroy the great bulk of the plants, but exceedingly difficult to eradicate the fragments here and there trodden into the mud or hidden under roots. The entire shore line of the St. Johns and all its tributaries would have to be carefully searched several seasons in succession. Eradication may be possible, but the writer greatly doubts its feasibility. Considering the immense extent of territory and the inaccessibility of a large part of it, it is not probable that every plant could be destroyed, and were a few left they would in the course of a few years reinfest the entire territory. If the plant forms seeds in Florida, which is thought to be the case, the difficulty would be greatly increased, as some of the seeds might retain their vitality for a number of years. On the whole, the writer has been forced to the conclusion that eradication is impracticable. He finds, furthermore, that those who have given the matter candid consideration mostly agree in this opinion. The evil, however, is certainly so serious that means should be devised, if possible, to keep it in check. This, it is believed, can be accomplished at fairly reasonable expense.

METHODS OF KEEPING THE PEST IN CONTROL.

The water hyacinth is easily killed in many ways, but only those methods which are thought to be the most practicable can be discussed here.

MECHANICAL DEVICES.

Probably the most feasible device for killing the plant is that suggested by Mr. Sackett, Assistant Engineer of the War Department. He recommends the "construction of a light-draft stern-wheel steamer, having a double bow or outrigger, which being forced into a mass of

plants would cause them to gather toward the middle of the boat, where an inclined carrier would pick them up and deposit them in front of rollers driven by machinery, which would force the water from them, thus greatly reducing their bulk. The crushed material could be delivered to barges alongside, to be deposited where no injury could again result, or a cremator could be arranged on a barge alongside of the boat, and so save additional handling."[1] It would seem to the writer perfectly feasible to construct the crushers suggested by Mr. Sackett

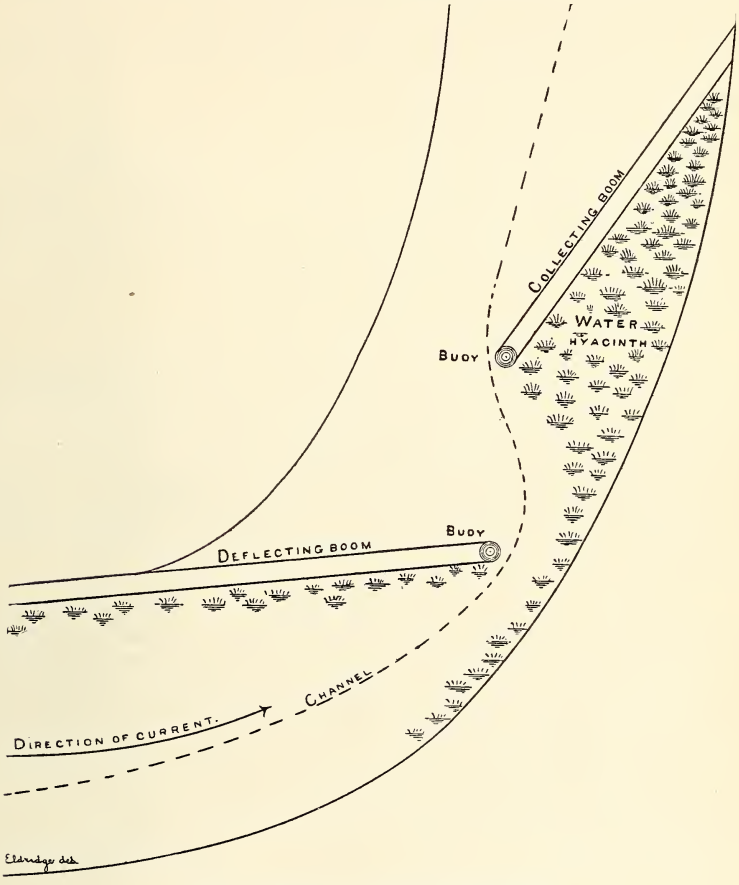

FIG. 4.—Booms for collecting drifting plants.

strong enough so that the plants would be destroyed, in which case the fragments could simply be dumped into the river. In an apparatus of this kind the danger to the machinery from hidden trash and logs must be considered. By having a lever with which the carrier could be quickly stopped a man constantly on guard could probably prevent serious accident to the machinery.

[1] Senate Report No. 1395, Fifty-fourth Congress, second session, p. 5, 1897.

A boat constructed like the above, but with carriers to deposit the plants on the shore instead of crushing them, could be used to advantage in many places. If worked in connection with booms constructed at points along the river to collect the plants, it is possible that this plan would prove more satisfactory than the above. Floating log booms could be constructed at favorable points, as shown in fig. 4, to collect the plants. The dredge working near the shore could then easily throw the plants out upon dry land. When all the plants which had accumulated at one point were destroyed, the dredge could proceed to another station. By destroying the plants thus collected at regular intervals along the river, which could be done at comparatively small expense, it is thought the river could be kept open to navigation. In case either method were followed, log booms should be placed across the entrances to bayous, creeks, etc., to confine the large masses of plants as far as possible and prevent their rapid reproduction. It has been demonstrated that this can be easily accomplished. The carrier device to deposit the plants on the shore would be particularly effective in canals. In regard to mechanical devices, however, it may be said that they are all simply temporary expedients.

PLACING DESTRUCTIVE SUBSTANCES IN THE WATER.

Pouring gasoline on the water and igniting it has been suggested as a means of killing the water hyacinth, but on account of the great expense this would entail and the danger from fire it is not believed to be practicable. Destruction by salting or poisoning the water or covering the surface with kerosene or crude petroleum has also been suggested, but it is believed that these methods would prove of little value.

FREEZES.

Such freezes as are likely to occur in Florida can not be expected to kill the water hyacinth. The writer carefully observed the effects of the very severe freezes of 1894 and 1895, and found that while the plants were severely injured few were entirely killed. The first freeze, that of December 29, 1894, killed the tops down to the surface of the water. These soon dried up, and the plant, relieved of the heavy top, arose in the water so that a considerable portion of the usually submerged base was exposed. The second freeze, February 9, 1895, killed this exposed portion, which normally would be covered, and yet the plants were not destroyed. The majority of them sprouted from the small remaining basal portion which was not injured. In most locations the cold weather of this winter (January 27, 28, 1897, 21° to 25° F.) killed the tops of the plants, but has only slightly checked their spread.

UTILIZATION OF THE WATER HYACINTH AS A MEANS OF REDUCING IT.

As mentioned above, the water hyacinth is a good food for cattle and hogs, and hundreds of these animals may be seen along the shores of the St. Johns in the winter grazing on the weed. The plant has been used to some extent for a fertilizer, being put on both when rotted and while green. With some garden crops, such as potatoes and cabbage, it is said to have given excellent results. The fertilizing properties of the plant must, however, be comparatively small, as a large percentage of it is air and water. However, the various uses to which the plant may be put can not be expected to involve its destruction to a sufficient extent to aid materially in keeping it under control.

PROBABLE EFFECT OF DISEASES IN CONTROLLING THE WATER HYACINTH.

From what has been said, it appears that the eradication of the water hyacinth by mechanical means is practically impossible, and that the use of dredges and other mechanical devices will simply result in keeping the plant in control at continuous expense. There is, however, another means of combating pests of this nature, namely, the introduction and spread of their natural enemies, which in some instances has proved thoroughly effective. The water weed, or water pest (*Philotria canadensis* (Michx.) Britton), which when first introduced into Europe caused very serious trouble in canals and rivers and then gradually disappeared, is probably a case of this nature. The female plants of the water weed were introduced into Ireland in 1836, into Great Britain in 1841, and later into many rivers and canals in middle, southern, and northern Europe. The weed multiplied rapidly and soon became very troublesome to navigation and fisheries in many canals and streams. After a number of years it became less abundant, reproducing less rapidly, and gradually decreasing in most places until it no longer causes serious trouble.[1] Many authorities attribute this decreased reproduction to the effect of natural enemies, which have gradually multiplied until they keep the pest under control. The water weed roots in the muddy bottoms of rivers and canals, and some authorities attribute the decreased numbers of the plant to the exhaustion in the soil of the specific nutriment on which the plant feeds. The water hyacinth, however, is a floating plant, having commonly no connection with the soil, and therefore could not be affected in this way.

The introduction of the lime tree (*Citrus limetta*) on some of the Florida keys furnishes an illustration of a similar nature. If the lime is introduced entirely free from its natural enemies it grows rapidly and thrives without culture. If, however, a single enemy of the lime, for instance, the purple scale insect (*Mytilaspis citricola*), be introduced, the trees will be killed to the ground, if not killed out entirely. If, however, when the purple scale is introduced, its fungous and insect

[1] Ascherson and Gürke, Hydrocharitaceae, in Engler and Prantl, Die Natürlichen Pflanzenfamilien, Theil II, Abt. I, p. 251. 1889.

enemies, which on the mainland of Florida keep the pest in control, are also introduced, the scale will probably not be allowed to increase rapidly enough to seriously injure the lime.[1]

The writer has made a careful search in Florida for diseases which may prove of importance in combating the water hyacinth and has discovered one leaf-spot malady which is widely distributed and unquestionably damages the plant considerably. This disease is caused by a parasitic fungus which attacks the leaves in spots, forming concentric circles, and ultimately kills the entire leaf. It is highly important, in the writer's opinion, that a careful search should be made in the native home of the plant for additional diseases which may be introduced here to aid in keeping the pest under control. Although it is by no means certain that any exceedingly virulent diseases would be found, yet many minor maladies would doubtless be discovered which would aid in controlling the weed. The introduction of the natural enemies of the plant, together with the remodeling of the bridges in order to allow the river current to carry as much of the material out to sea as possible, would probably keep the pest down so that it would not seriously obstruct navigation. This would necessitate but small initial expense and, if successful, would permanently solve the question.

[1]Throughout the principal regions of Florida where the lime and other citrous fruits are grown, the purple scale is attacked by a very virulent fungous disease. This is caused by *Ophionectria coccicola* E. and E., which has been shown by experiment to be very effective in keeping this pest under control. Under ordinary circumstances this disease, aided by the ladybird beetle and other parasitic enemies, so thoroughly destroys the purple scale that it causes no serious damage.

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